Use of Real-time Satellite Precipitation Data for Monitoring Floods and Droughts over Africa and Latin America

Eric F. Wood, Ming Pan, Justin Sheffield, Colby Fisher, Nathaniel Chaney, Princeton University

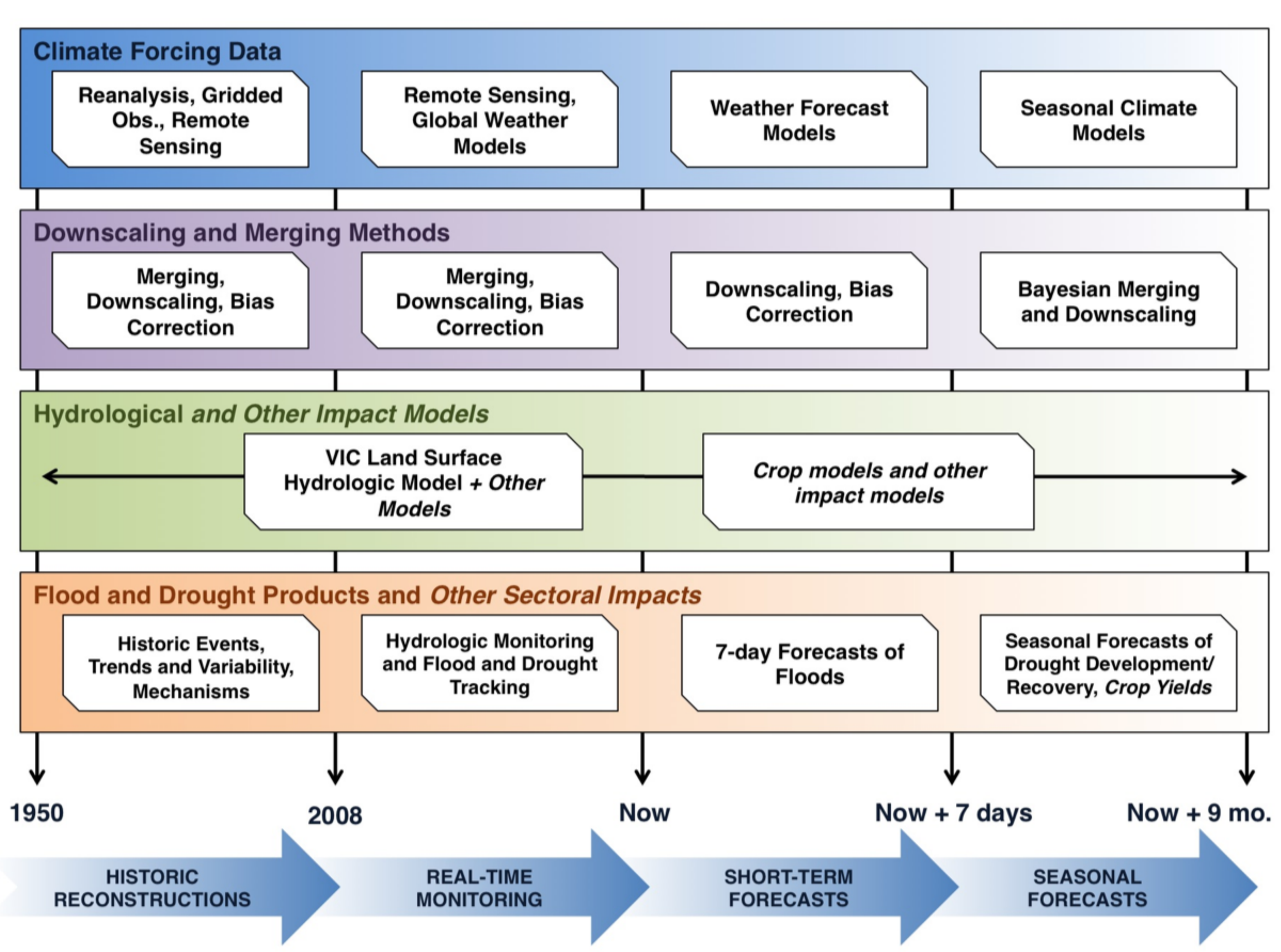
Introduction

Climate services are key to improving resilience in regions that are susceptible to natural hydrometeorological hazards and suffer from lack of capacity to manage climate related resources and impacts. The Global Precipitation Measurement mission (GPM) is critical to the provision of climate services especially in developing regions where on the ground networks are sparse or unreliable. In general, satellite remote sensing has transformed our ability to monitor the terrestrial water cycle, natural vegetation and agriculture over large extents. Following on from the hugely successful TRMM and its use in a variety of applications related to water, the GPM is poised to transform our ability to provide climate services, but with higher accuracy, more precision in terms of precipitation types and global coverage.

The overall objective is to demonstrate the feasibility of delivering climate services based on GPM data by making accessible to users satellite data that has utility for decision making and thereby enhancing their resilience to natural hydrometeorological disasters. This objective has the implication that for most decision makers and application users, satellite precipitation is too difficult to obtain, its skill and reliability as yet unproven, and the tools to merge in-situ data undeveloped. Our work in Africa and Latin America, where we have implemented TMPA/GPM satellite precipitation within our monitoring and forecasting systems support this objective.

The Monitoring/Forecast System

The system comprises three parts: (1) a retrospective reconstruction of the global terrestrial water cycle forced by merged reanalysis/observational meteorological forcing. This forms the climatology against which current and future conditions are compared; (2) a real-time monitoring system driven by remote sensing precipitation and atmospheric analysis data that tracks drought conditions in near real-time; (3) a forecasting system using weather and seasonal forecasting models to produce 7-day forecasts for most variables as well as some 6-month forecasts at the monthly timestep.



The VIC model is run in near real-time forced by a mixture of observations and modeled/remotely sensed meteorology to produce updates of water cycle variables (soil moisture, runoff, and evapotranspiration). Drought is monitored in terms of low soil moisture percentiles, streamflow percentiles, the Standardized Precipitation Index and NDVI. By combining an analysis of all of these components, we are able to use the AWCM to identify historical events and to provide an early warning of events in the near future.

Multiple variables are also calculated at each grid cell over the continent using the land surface model for display and to be retrieved as time series. In addition to this, 7-day forecasts are created for most variables using GFS, as well as 6-month forecasts created for precipitation and other variables using a number of models.

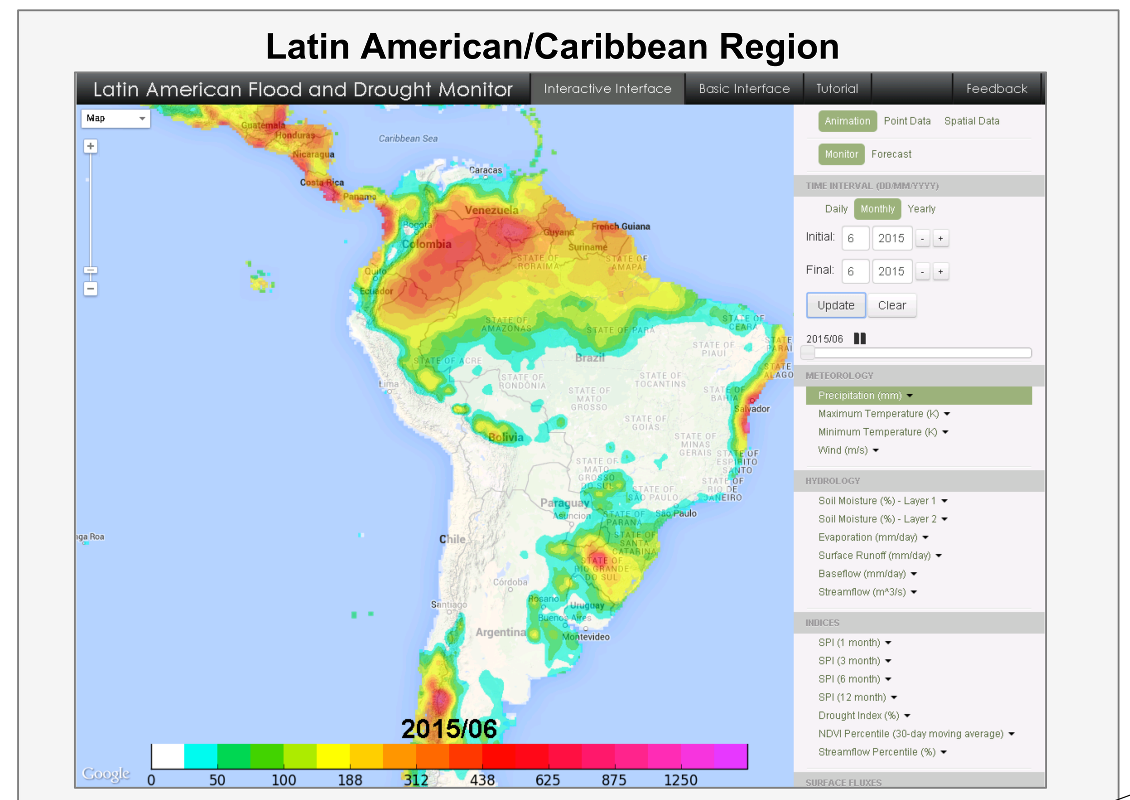
The African and Latin American/Caribbean Flood and Drought Monitors (AFDM, LACFDM)

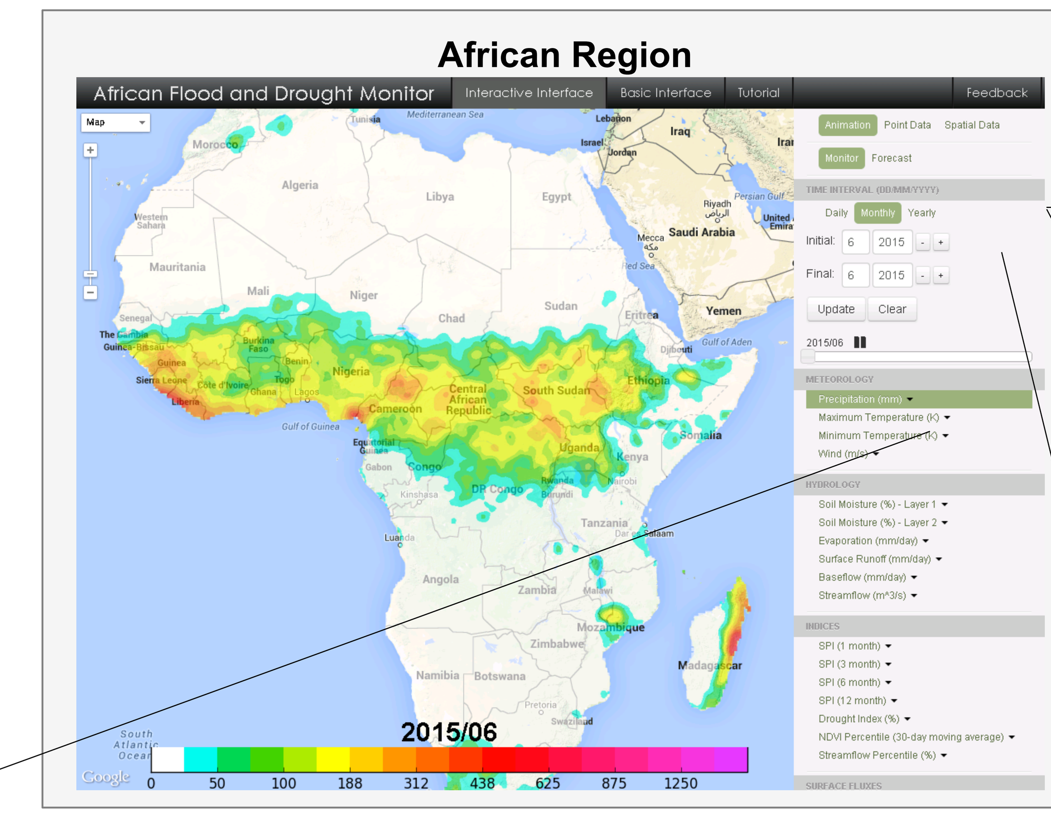
The centerpiece of our approach is the existing Princeton University African and Latin American/Caribbean Flood and Drought Monitors (AFDM, LACFDM). These two continental systems have been developed as subsets of our global system.

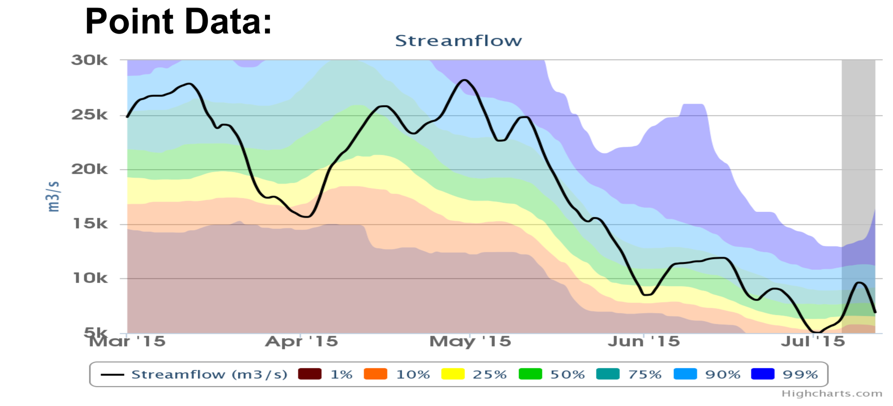
The systems monitor and forecast the land surface hydrological cycle and its extremes using satellite remote sensing and weather/climate model forecasts to drive a hydrological land surface model. Google Maps is used to provide the user an enhanced experience in viewing and accessing the monitor.

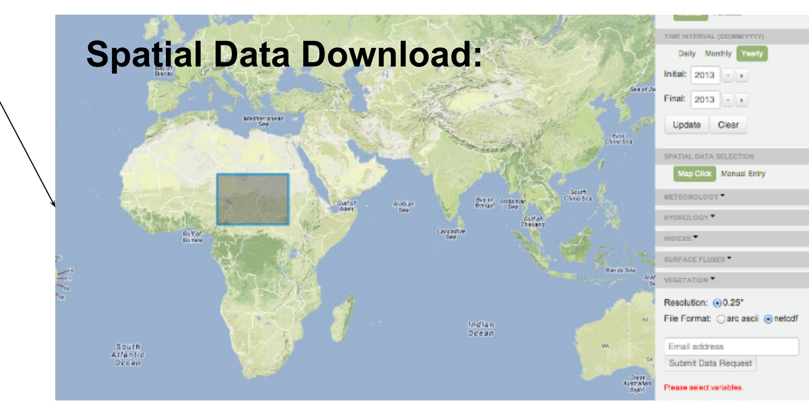
Users can access the entire daily, monthly, and yearly records from 1950 to two days before real-time, as well as 7-day and 6-month forecasts. The monitor output areal data can be viewed as animations or static images.

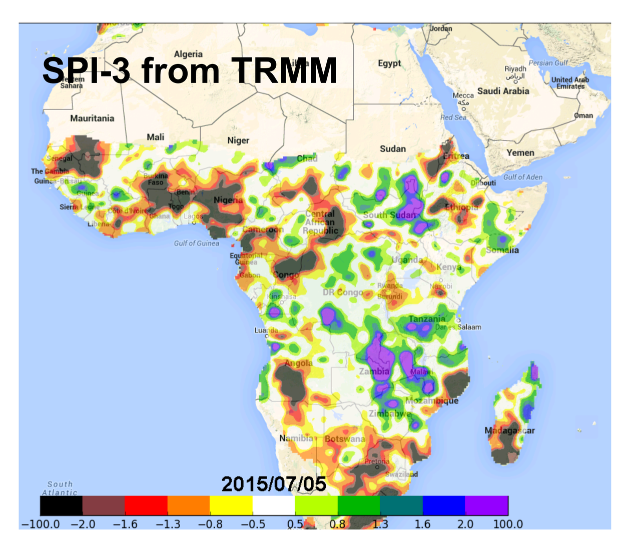
To view the monitor, please visit: http://stream.princeton.edu/

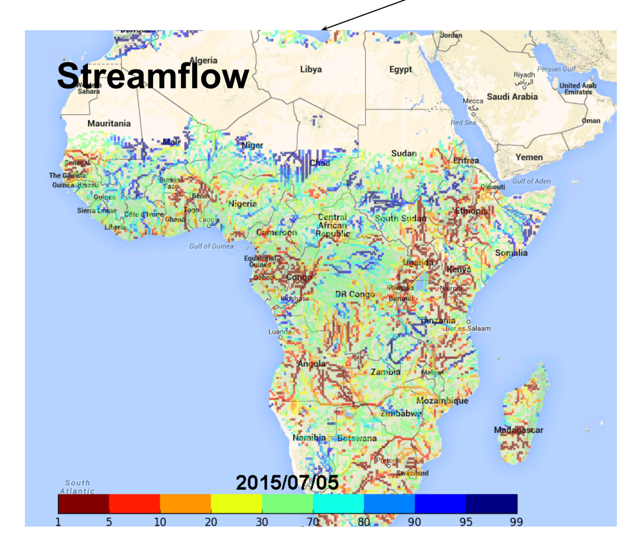


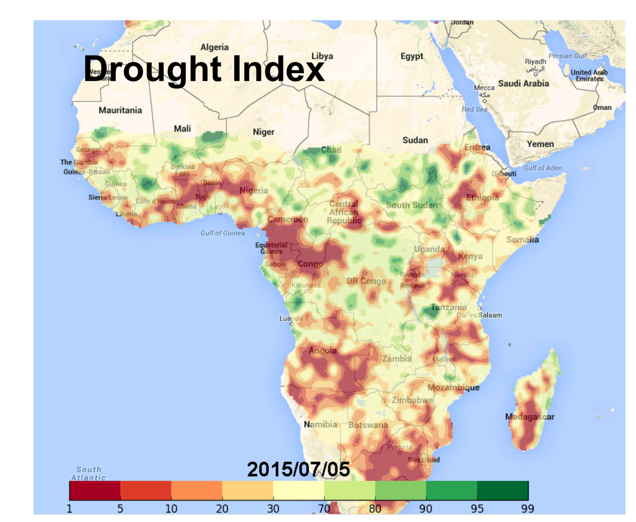


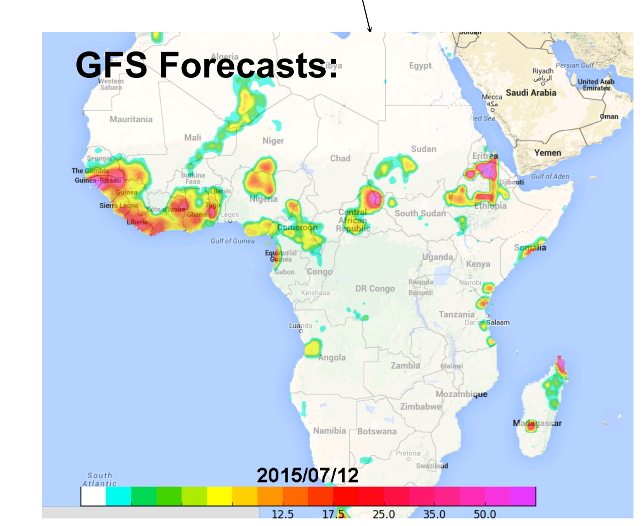


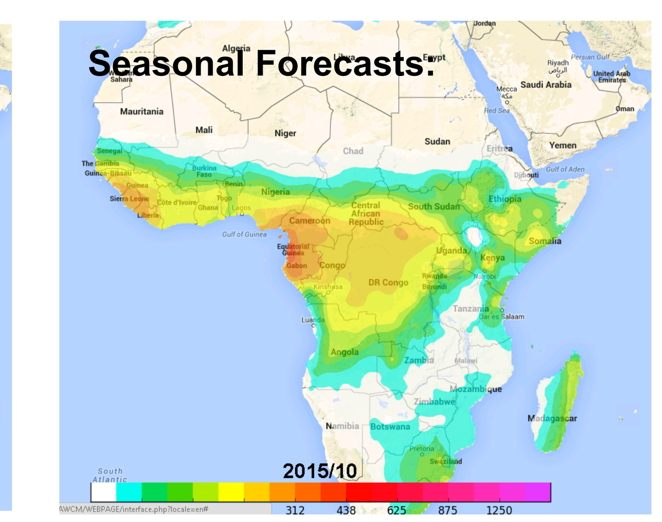




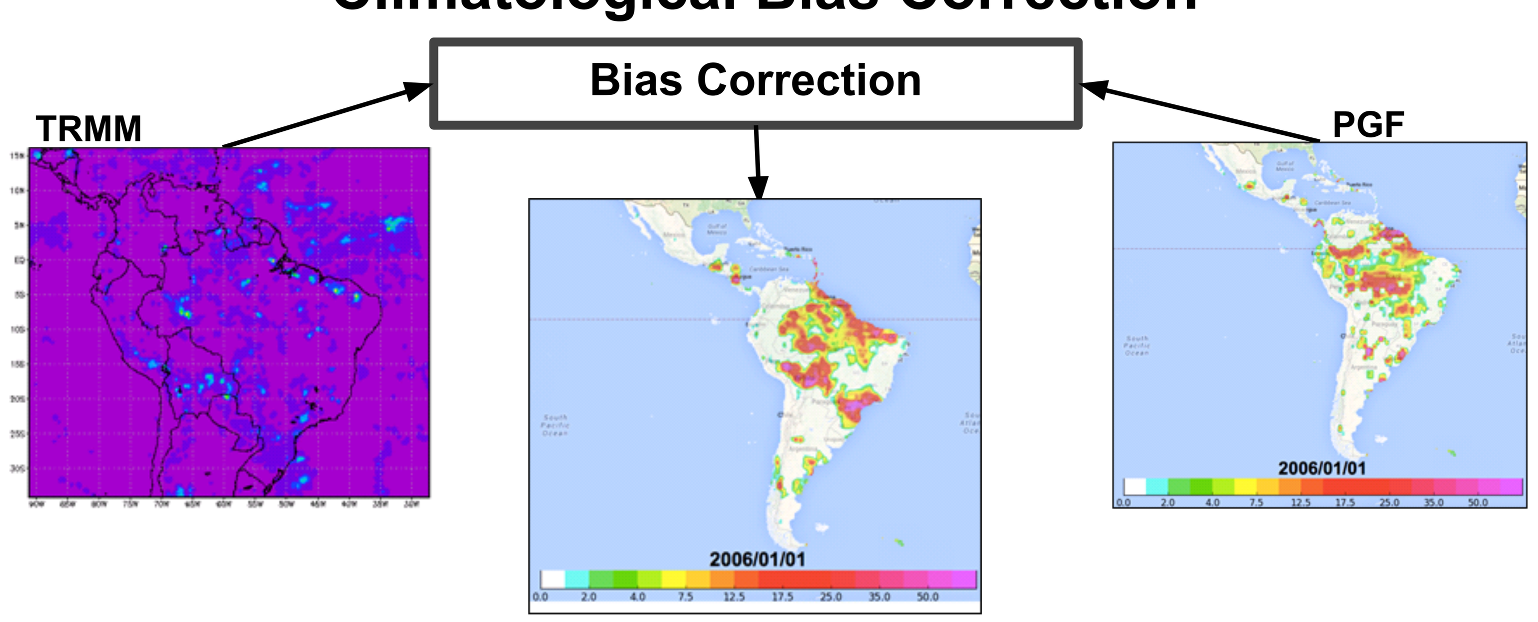




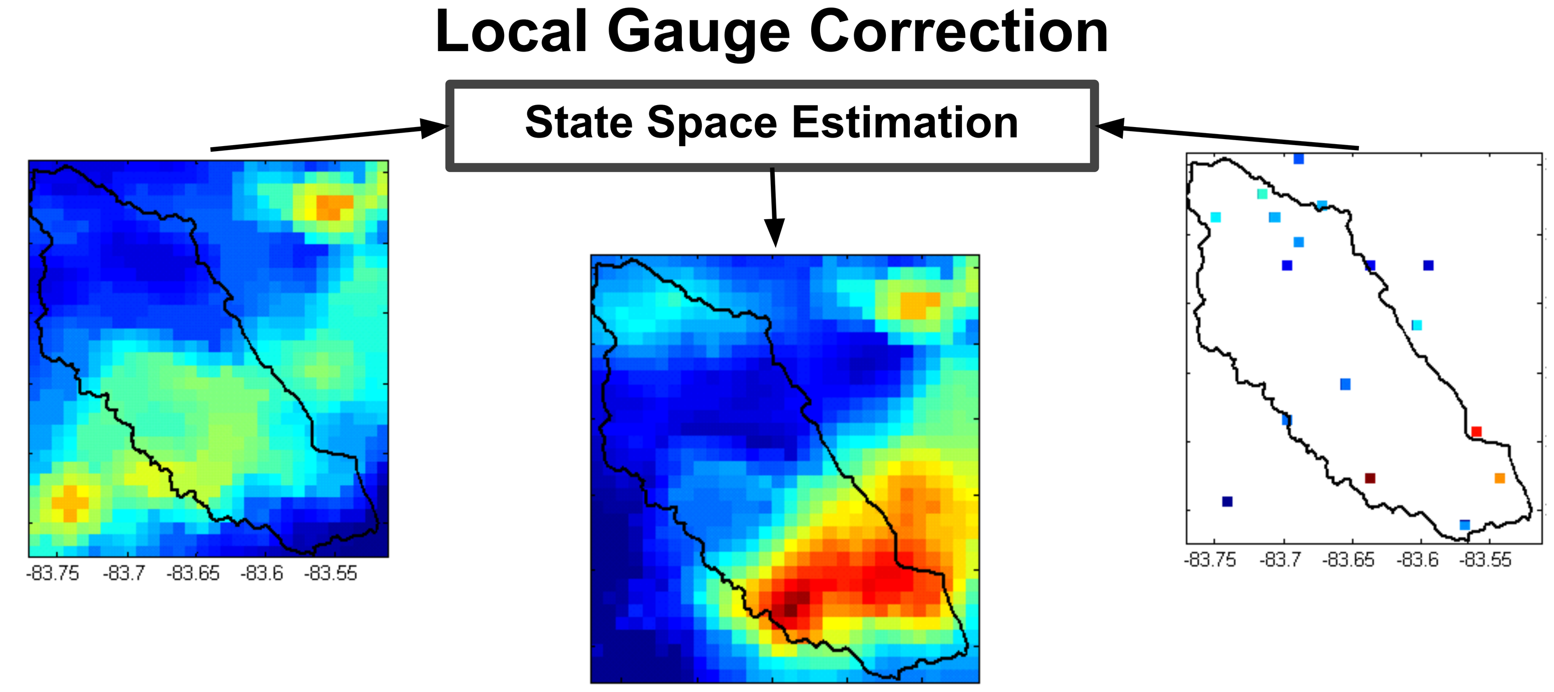




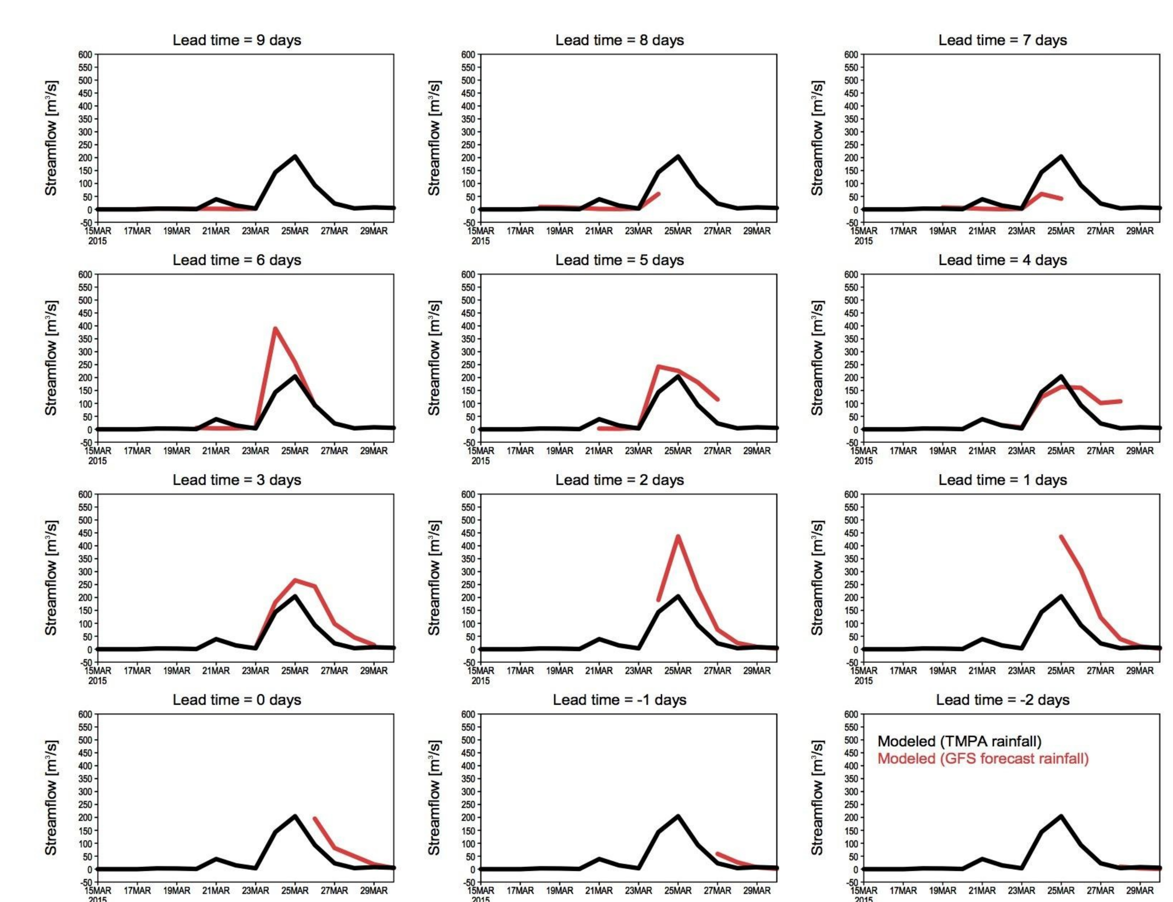
Climatological Bias Correction

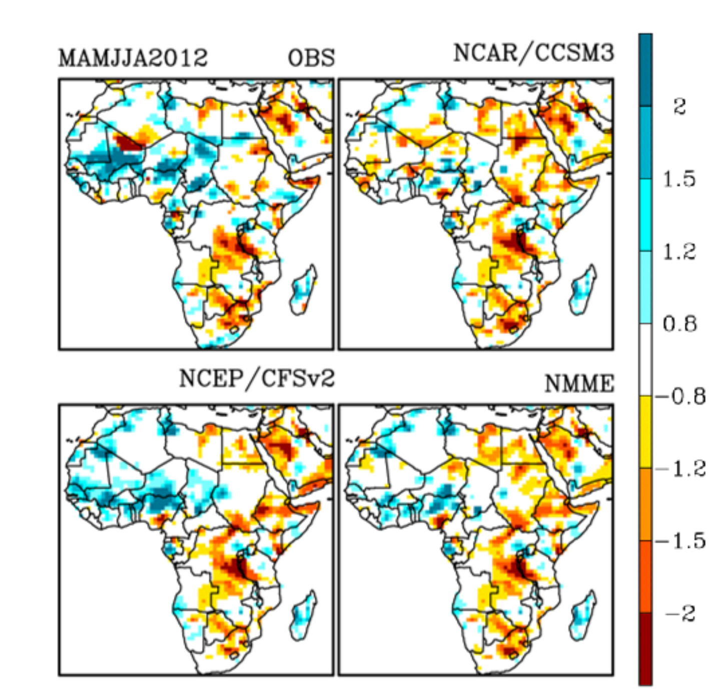


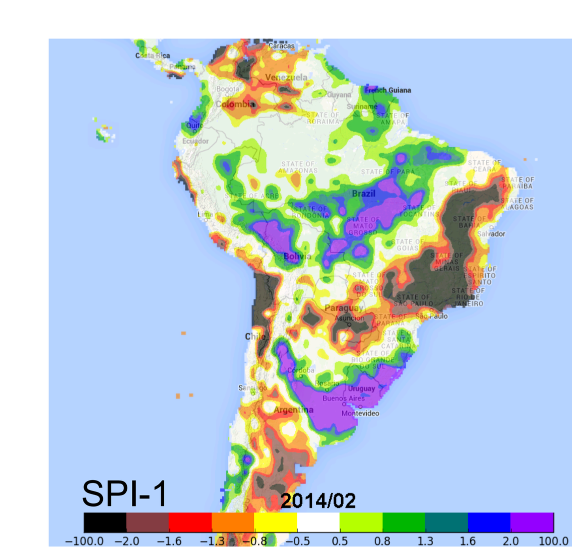
Local Gauge Correction



Case Studies







Top: LACFDM prediction of the March 2015 flood in Copiapó, northern Chile. Each panel represents the streamflow forecast (red line) at different lead-time versus the observation driven simulation (black line), from 9 days before the event to 2 days after the event.

Top-right: Observed 3-month Standardized Precipitation Index (SPI-3) during the 2012 African drought versus forecasts from NMME models.

Right: LACFDM shows the drought condition in terms of SPI-1 calculated from TRMM over the southeast of Brazil in 2014.

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